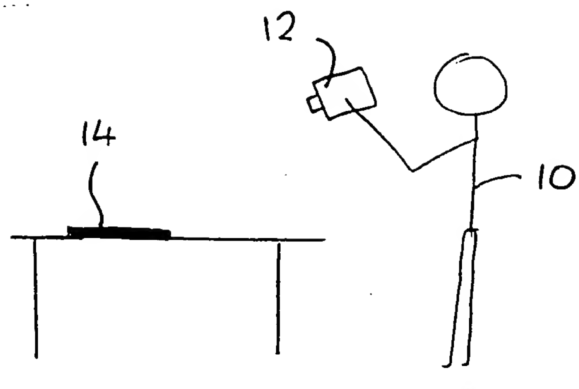

FIG.1

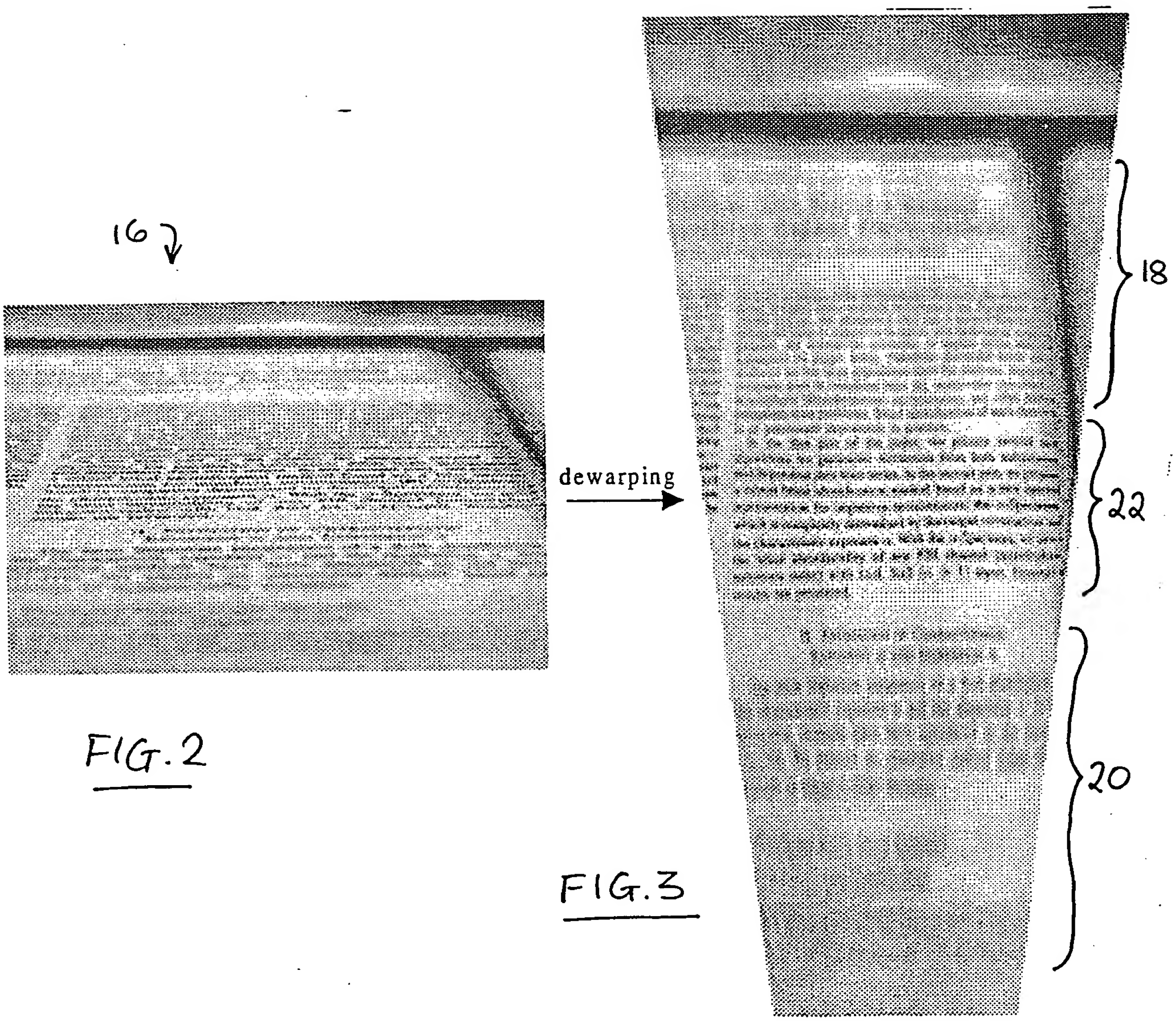

FIG.2

FIG.3

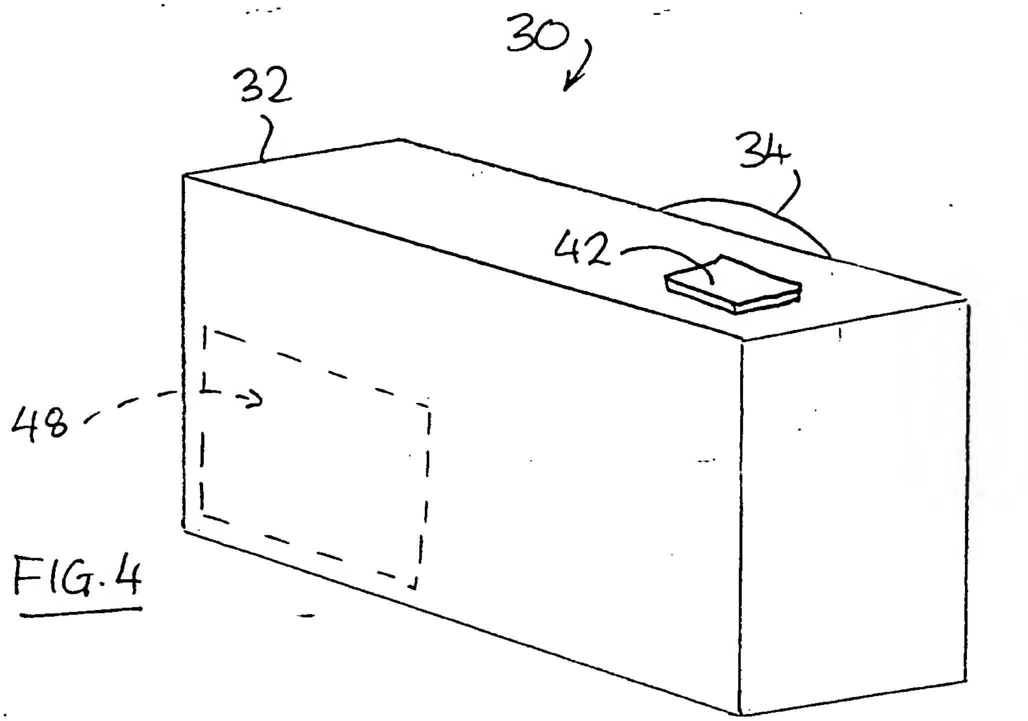
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FIG. 4

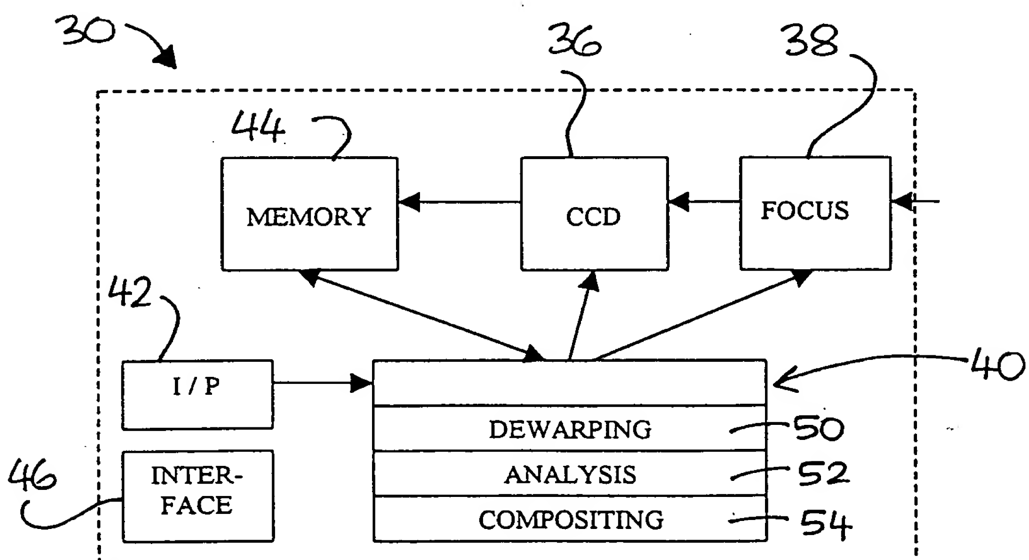

30
36
38
44
MEMORY
CCD
FOCUS
42
I / P
40
DEWARPING
50
ANALYSIS
52
COMPOSITING
54
46
INTER-
FACE

FIG. 5

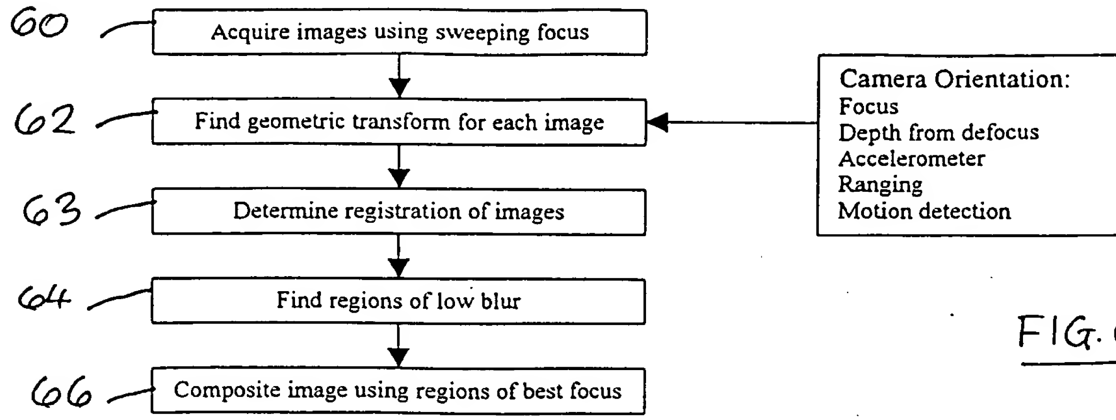


FIG. 6

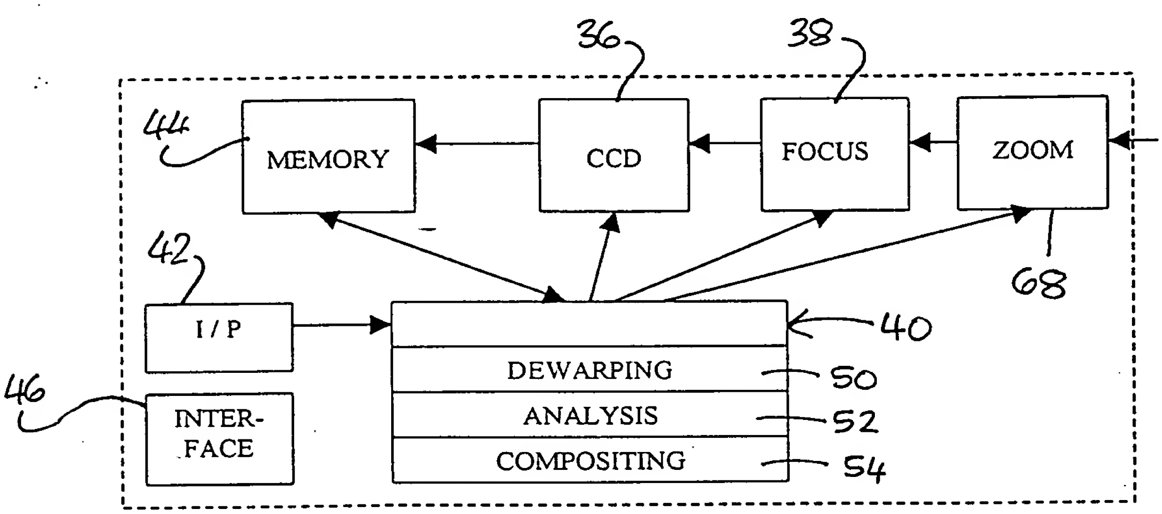


FIG. 7

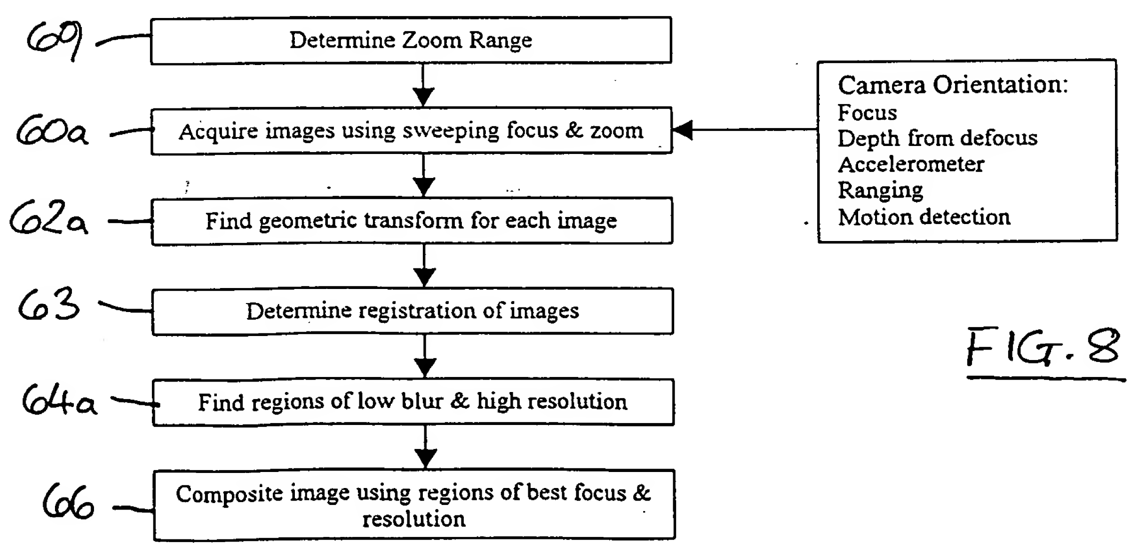


FIG. 8

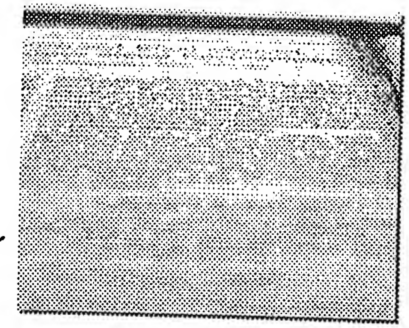


FIG. 9(a)

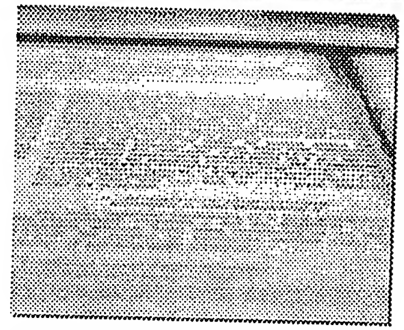


FIG. 9(b)

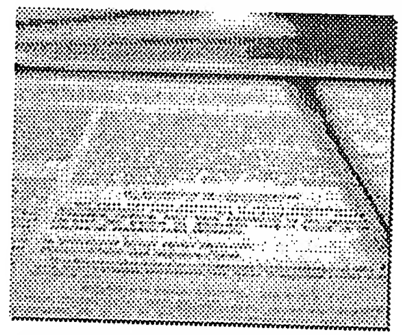


FIG. 9(c)

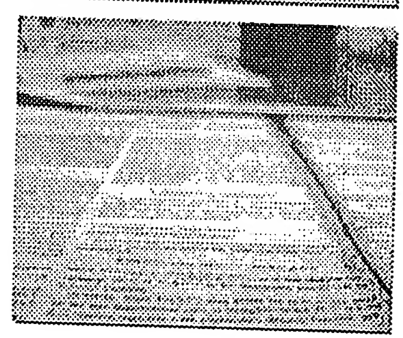
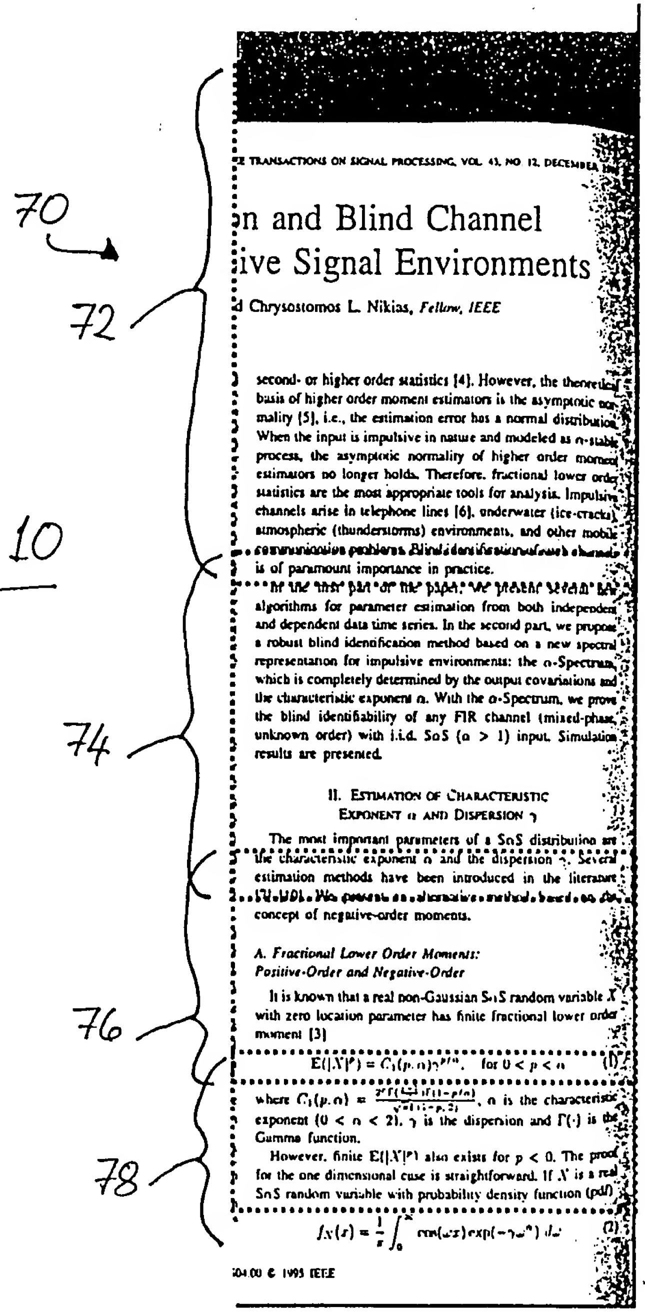


FIG. 9(d)



E TRANSACTIONS ON SIGNAL PROCESSING, VOL. 43, NO. 12, DECEMBER

on and Blind Channel
ive Signal Environments

d Chrysostomos L. Nikias, *Fellow, IEEE*

second- or higher order statistics [4]. However, the theoretical basis of higher order moment estimators is the asymptotic normality [5], i.e., the estimation error has a normal distribution. When the input is impulsive in nature and modeled as α-stable process, the asymptotic normality of higher order moment estimators no longer holds. Therefore, fractional lower order statistics are the most appropriate tools for analysis. Impulsive channels arise in telephone lines [6], underwater (ice-cracks), atmospheric (thunderstorms) environments, and other mobile communication problems. Blind identification of such channels is of paramount importance in practice.

In the first part of the paper, we present several new algorithms for parameter estimation from both independent and dependent data time series. In the second part, we propose a robust blind identification method based on a new spectral representation for impulsive environments: the α-Spectrum, which is completely determined by the output covariations and the characteristic exponent α. With the α-Spectrum, we prove the blind identifiability of any FIR channel (mixed-phase, unknown order) with i.i.d. SαS ($\alpha > 1$) input. Simulation results are presented.

II. Estimation of Characteristic Exponent α and Dispersion γ

The most important parameters of a SαS distribution are the characteristic exponent α and the dispersion γ. Several estimation methods have been introduced in the literature [7]–[10]. We present an alternative method based on the concept of negative-order moments.

A. Fractional Lower Order Moments: Positive-Order and Negative-Order

It is known that a real non-Gaussian SαS random variable X with zero location parameter has finite fractional lower order moment [3]

$$E(|X|^p) = C_1(p,\alpha)\gamma^{p/\alpha}, \quad \text{for } 0 < p < \alpha \qquad (1)$$

where $C_1(p,\alpha) = \frac{2^{p}\Gamma(\frac{p+1}{2})\Gamma(1-p/\alpha)}{\sqrt{\pi}\,\Gamma(1-p/2)}$, α is the characteristic exponent ($0 < \alpha < 2$), γ is the dispersion and $\Gamma(\cdot)$ is the Gamma function.

However, finite $E(|X|^p)$ also exists for $p < 0$. The proof for the one dimensional case is straightforward. If X is a real SαS random variable with probability density function (pdf)

$$f_X(x) = \frac{1}{\pi}\int_0^{\infty} \cos(\omega x)\exp(-\gamma\omega^{\alpha})\,d\omega \qquad (2)$$

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FIG. 10